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## The Origin of the Universe: A Vast and Expanding Universe

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*THE ORIGIN OF THE  
UNIVERSE*  
*A Vast & Expanding Universe*

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# *THE ORIGIN OF THE UNIVERSE*

## *A Vast & Expanding Universe*

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## WE LIVE IN A VAST UNIVERSE



- 100 billion galaxies, each with 100 billion stars.
- Image of Universe 13 billion years ago.

THE ORIGIN OF THE UNIVERSE: A VAST AND EXPANDING UNIVERSE



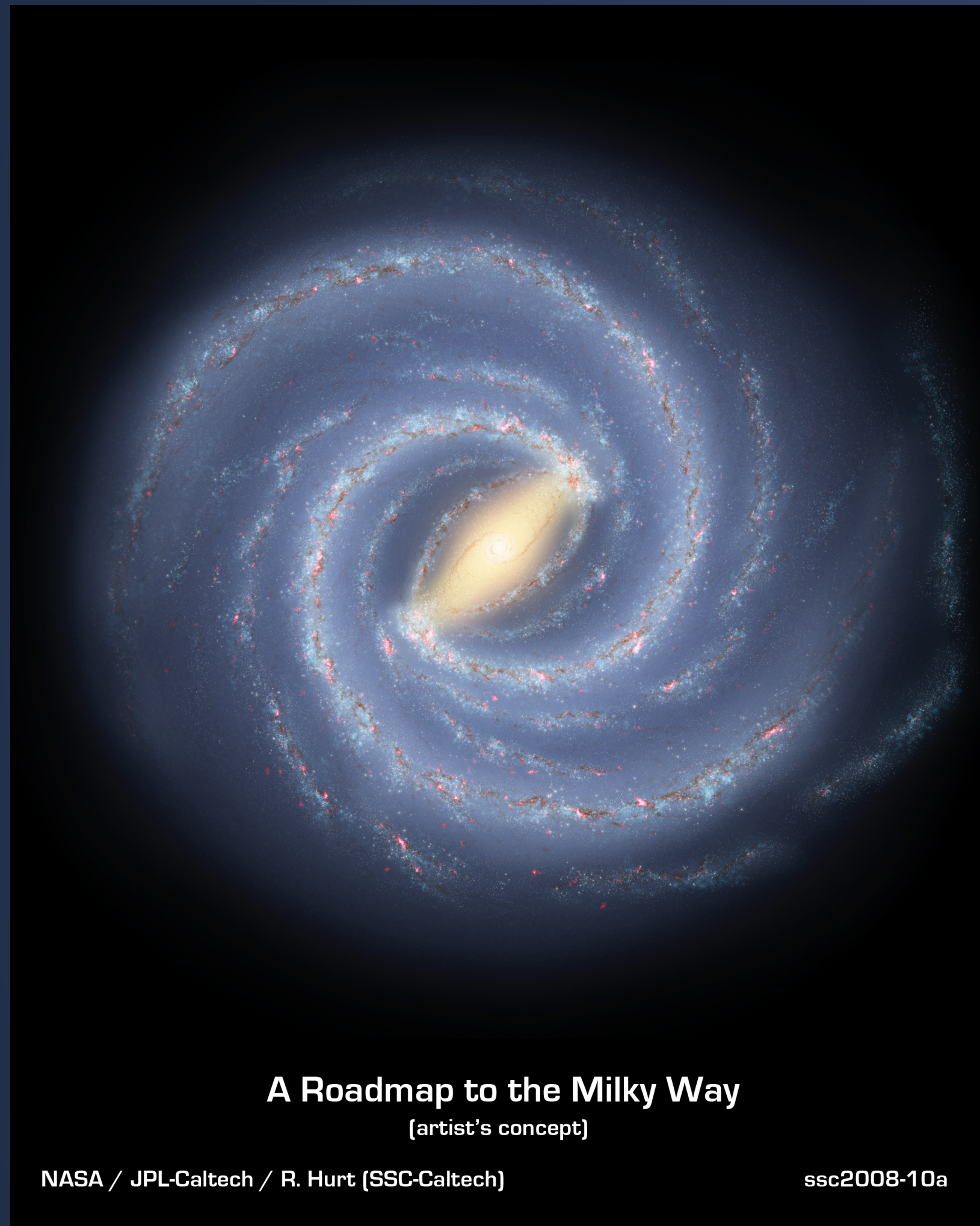
## HUBBLE 1925



- Edwin Hubble with telescopes in Mt. Wilson, California discovered our vast and expanding universe.



## BEFORE HUBBLE, ONLY THE MILKY WAY



- We thought the universe was our galaxy: The Milky Way



## AN EXPANDING UNIVERSE

- Edwin Hubble: The galaxies are moving away from each other.
- The phenomenon of Redshift.
- We live in an expanding universe.



## OUR UNIVERSE STARTED AS A DOT WITH INFINITE ENERGY IN THE BIG BANG



If our universe has been expanding, we can run the movie backwards?

We come to the Big Bang.



## THE 14-BILLION YEAR JOURNEY OF OUR UNIVERSE

From the beginning:

- 10-11 seconds: Matter wins over Anti-Matter
- 10-5 seconds: Protons and Neutrons form from Quarks
- 380,000 years: Cosmic Microwave Background Radiation (COBE)



## FROM THE FIRST STARS UNTIL TODAY

- 300 million years: Stars and Galaxies form
- 3 billion years: Galaxies and Clusters of Galaxies
- 9 billion years (4.7 billion years ago): Our Solar System forms
- 13.7 billion years: Today

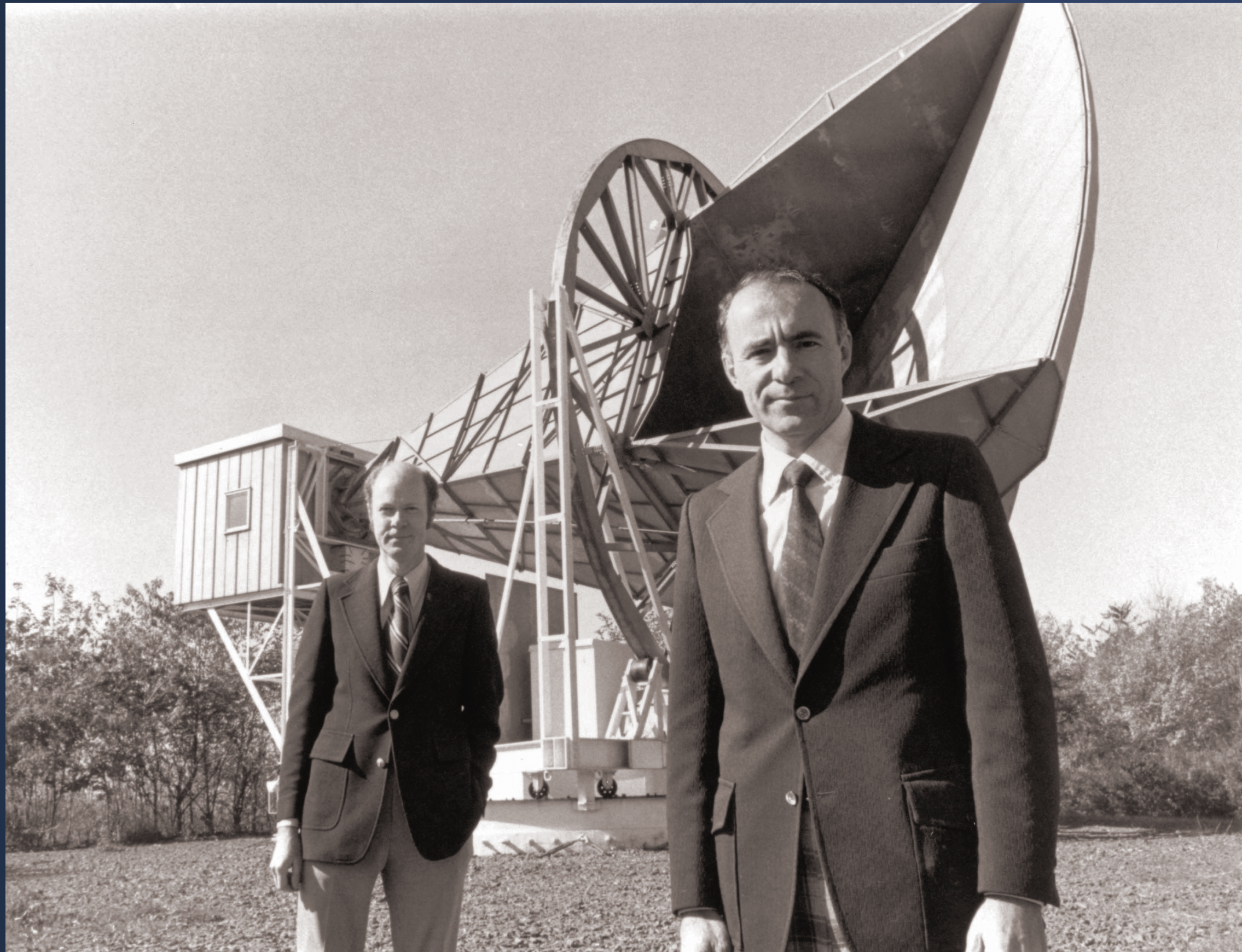


## EXPERIMENTAL EVIDENCE FOR THE BIG BANG

- Physicists showed that the Big Bang should have left a relic.
- Temperature of 5 degrees above absolute zero.
- Absolute zero is minus 273 degrees Celsius.



## PROOF OF THE BIG BANG



- In 1964, two engineers at Bell labs in New Jersey, Penzias and Wilson, discovered this relic radiation from the Big Bang.
- They received the Nobel Prize.

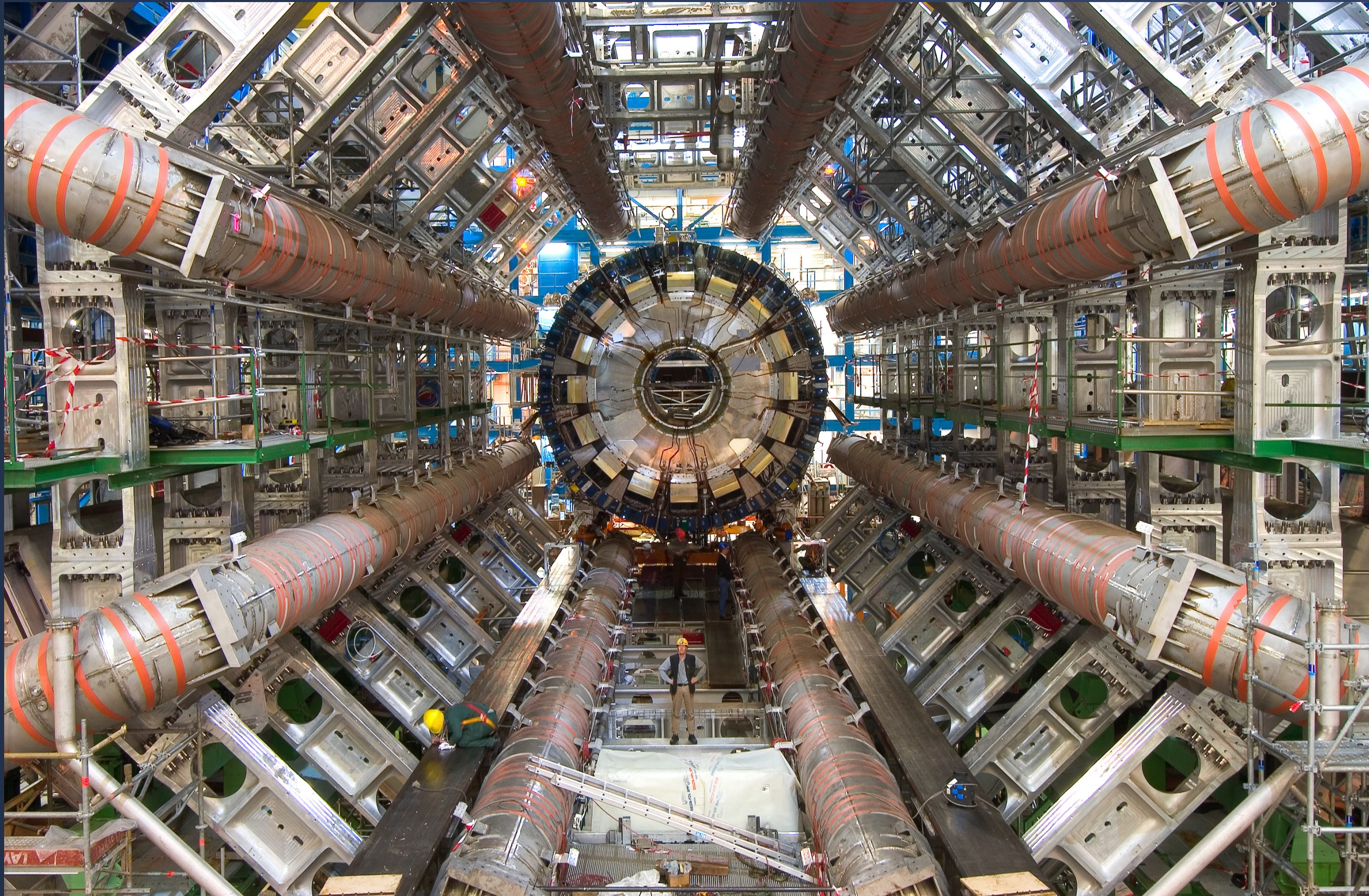




- Albert Einstein
- George Lemaitre, a Belgian priest
- Edwin Hubble



## MOST POWERFUL PARTICLE ACCELERATOR: CERN LARGE HADRON COLLIDER



- Physics Theories predict the existence of particles.
- Colliders “look” for them.
- Finding the particles show our theories are correct.



## DISCOVERY OF HIGGS BOSON (GOD-PARTICLE)

- Predicted in 1964 by Peter Higgs: To explain why particles have mass.
- July 4, 2012: Announcement that the LHC had detected the Higgs Boson.
- Over 5,000 physicists worked to achieve this result.

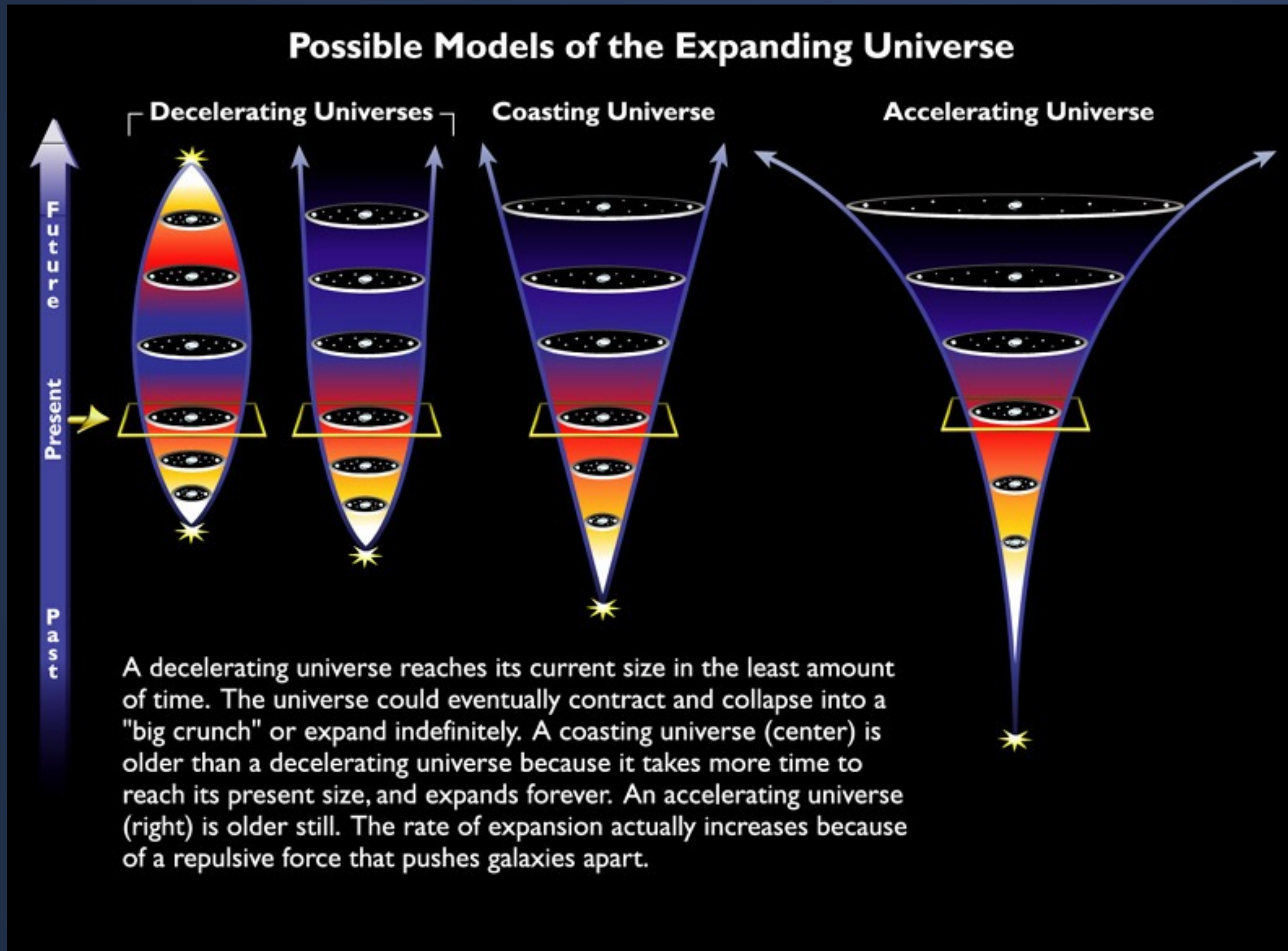


## THAT WAS OUR PAST, WHAT IS OUR FUTURE?

- In another 6 billion years, our Sun will become a Red Giant.
- Temperatures will rise to 3,000 Fahrenheit.
- Next, the Sun will become a White Dwarf.
- Earth will become cold and frozen.



# THE FUTURE OF THE UNIVERSE





# THE FUTURE OF THE UNIVERSE (VERSION 1)

<b>BIG FREEZE</b>	The universe will get colder and colder.
<b>HEAT DEATH</b>	Back to the Big Bang.
<b>BIG BOUNCE</b>	The universe will bounce back and expand again.



## THE FUTURE OF THE UNIVERSE (VERSION 2)

**BIG FREEZE:** The universe will get colder and colder.

**HEAT DEATH:** Back to the Big Bang.

**BIG BOUNCE:** The Universe will bounce back and expand again.



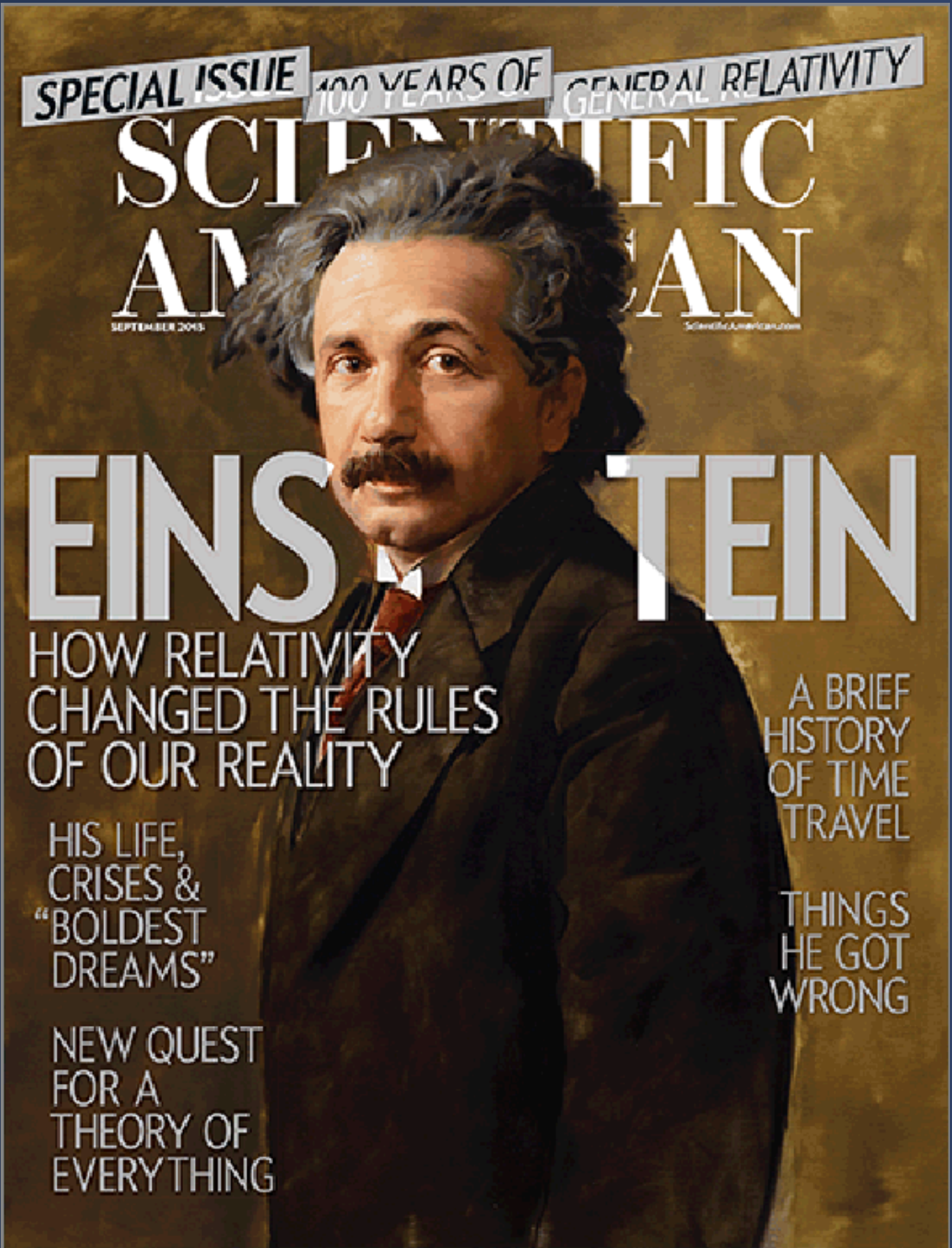
# ORIGIN OF THE UNIVERSE

## AN AMAZING AND MYSTERIOUS UNIVERSE

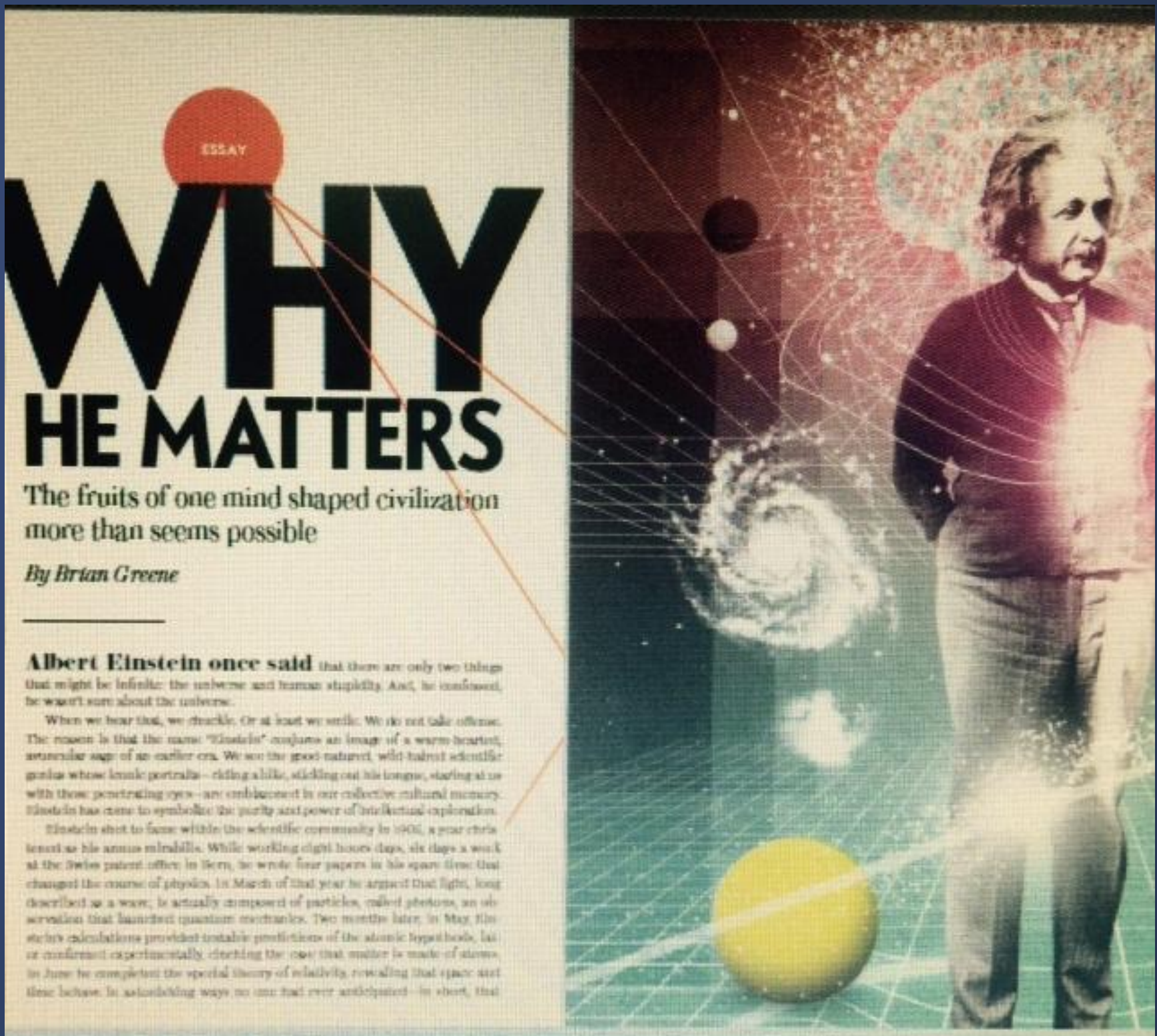


# ALBERT EINSTEIN & OUR AMAZING UNIVERSE

## 1915: General Relativity



## Black Holes Gravitational Waves



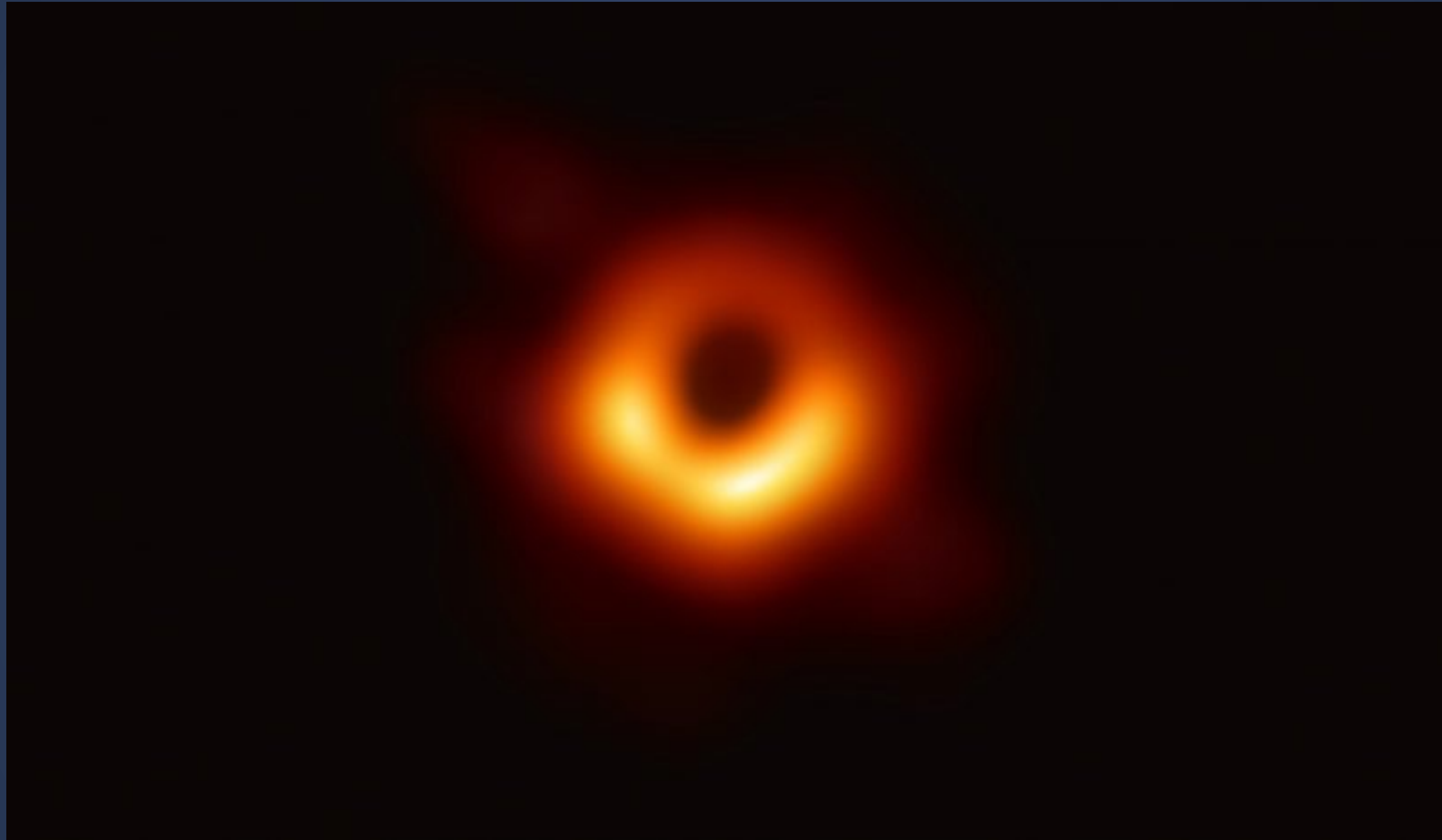


## AMAZINGLY, WE HAVE DETECTED GRAVITATIONAL WAVES

- LIGO (Laser Interferometer Gravitational-Wave Observatory)
- February 11, 2016: Gravitational Waves coming from the collision of two giant black holes 1.3 billion years ago.
- Exactly as predicted by Albert Einstein 100 years before.



WE HAVE "SEEN" A BLACK HOLE IN MESSIER M87\*





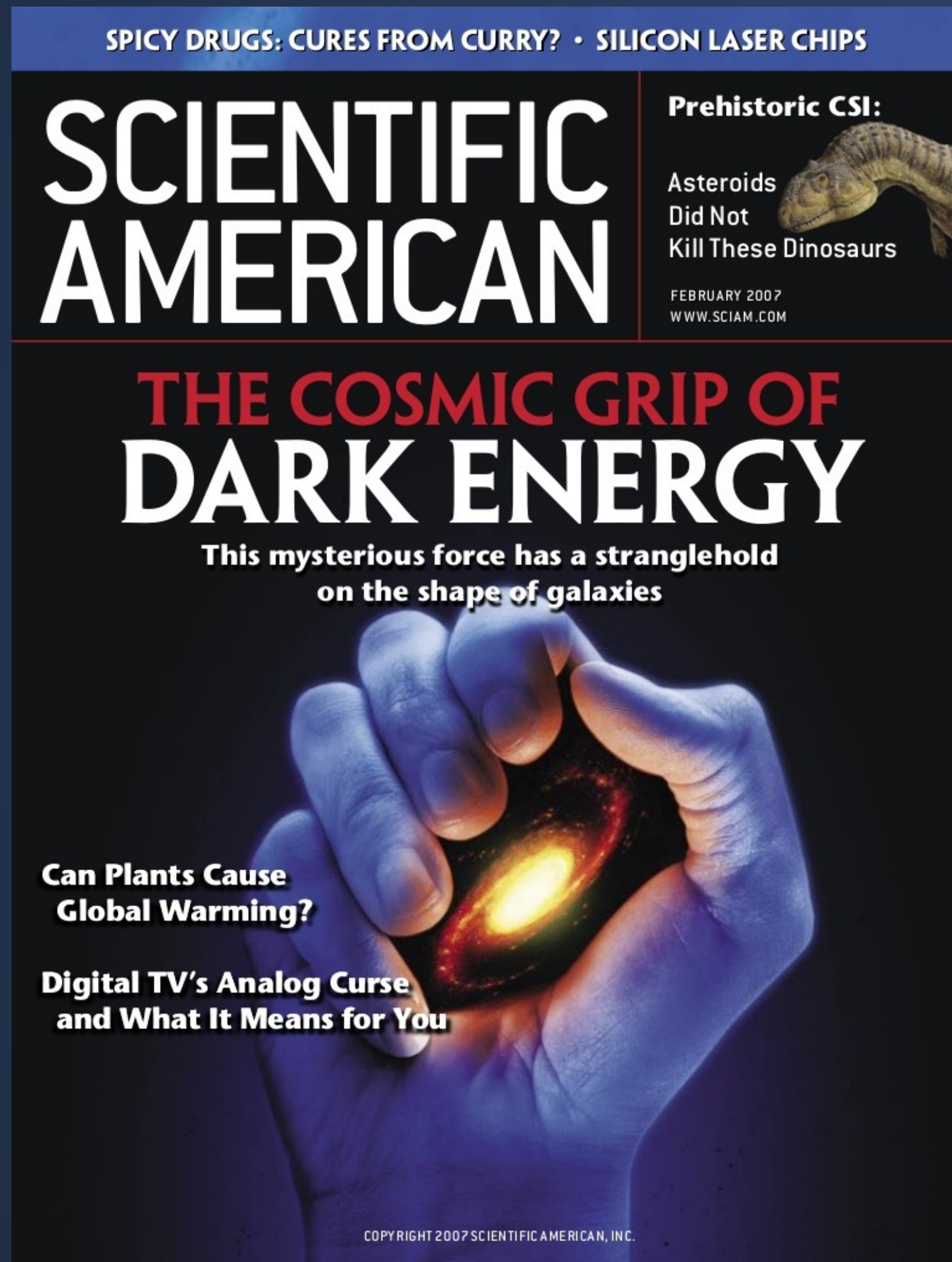
## EVENT HORIZON TELESCOPE WHICH “TOOK THE PICTURE”



- The ALMA Telescope array in Chile, one of 8 around the world.



## BUT THE UNIVERSE HOLDS MANY MYSTERIES: DARK ENERGY



- The expansion of the universe is accelerating.
- An unknown, “Dark Energy”, is pushing the acceleration.
- It comprises 70% of the universe.



## THE UNIVERSE STILL HOLDS MANY MYSTERIES: DARK MATTER (VERSION 1)

Vera Rubin: the stars at the edges of galaxies are moving faster  
the laws of gravity predict.

- The Explanation:  
**Dark Matter**
- It makes up 25% of the universe.
- So we can see only 5% of the universe.
- We live in a mysterious universe.





The stars at the edges of galaxies are moving faster  
than the laws of gravity predict.

– **VERA RUBIN**

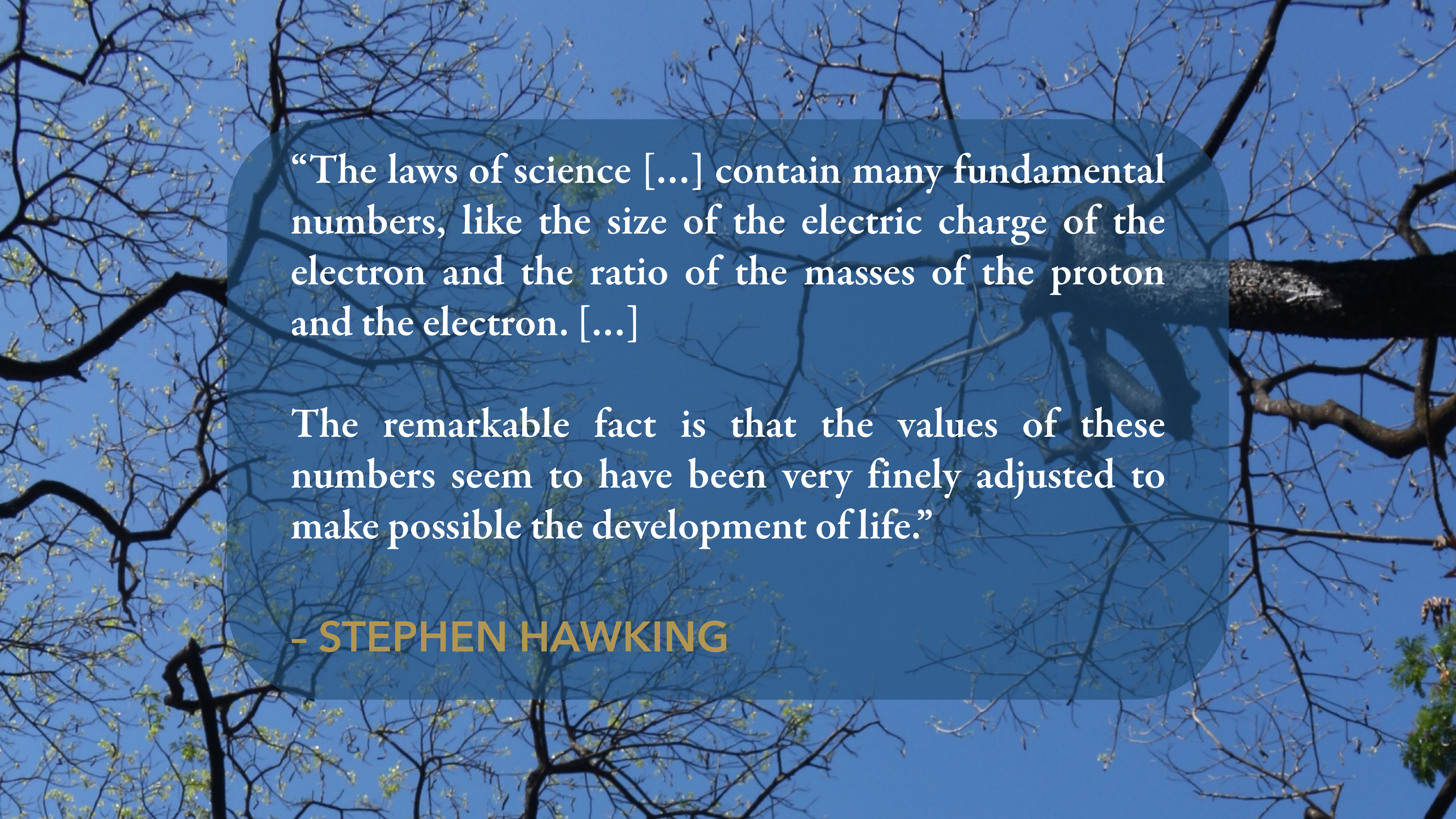




## THE UNIVERSE STILL HOLDS MANY MYSTERIES: DARK MATTER (VERSION 2.3)

- The Explanation: **Dark Matter.**
- It makes up 25% of the universe.
- So we can see only 5% of the universe.
- We live in a mysterious universe.





“The laws of science [...] contain many fundamental numbers, like the size of the electric charge of the electron and the ratio of the masses of the proton and the electron. [...]

The remarkable fact is that the values of these numbers seem to have been very finely adjusted to make possible the development of life.”

**- STEPHEN HAWKING**



## WE ARE HERE BECAUSE MATTER FORMED INTO STARS, GALAXIES, AND THE STARDUST THAT IS US

- At some point, there is slightly more matter than anti-matter.
- Matter forms into protons and neutrons, helium, lithium, and heavy hydrogen nuclei.
- 3 billion years: stars and galaxies form
- The matter in our bodies comes from the stars.



## THE 4 FUNDAMENTAL FORCES OF THE UNIVERSE “PREPARED” FOR US

- GRAVITY
- ELECTROMAGNETISM
- WEAK FORCE
- STRONG FORCE



## IF THE OTHER FORCES WERE STRONGER

- Stars and galaxies would not have formed.
- The elements in our bodies come from the stars.
- We would not be here.

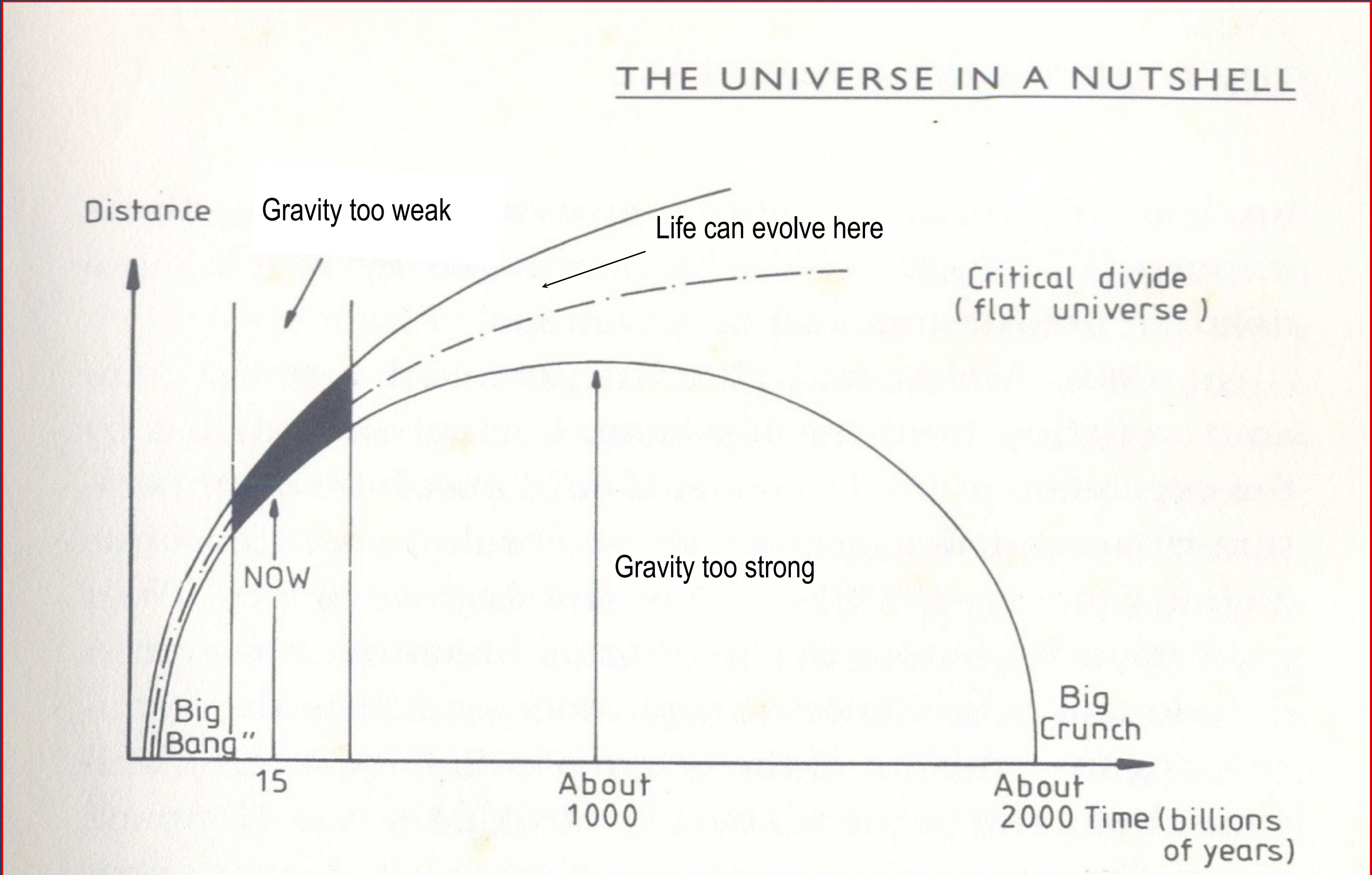


## IF THE OTHER FORCES WERE WEAKER (GRAVITY STRONGER)

- Stars and galaxies would have collapsed sooner.
- No time for life to evolve.

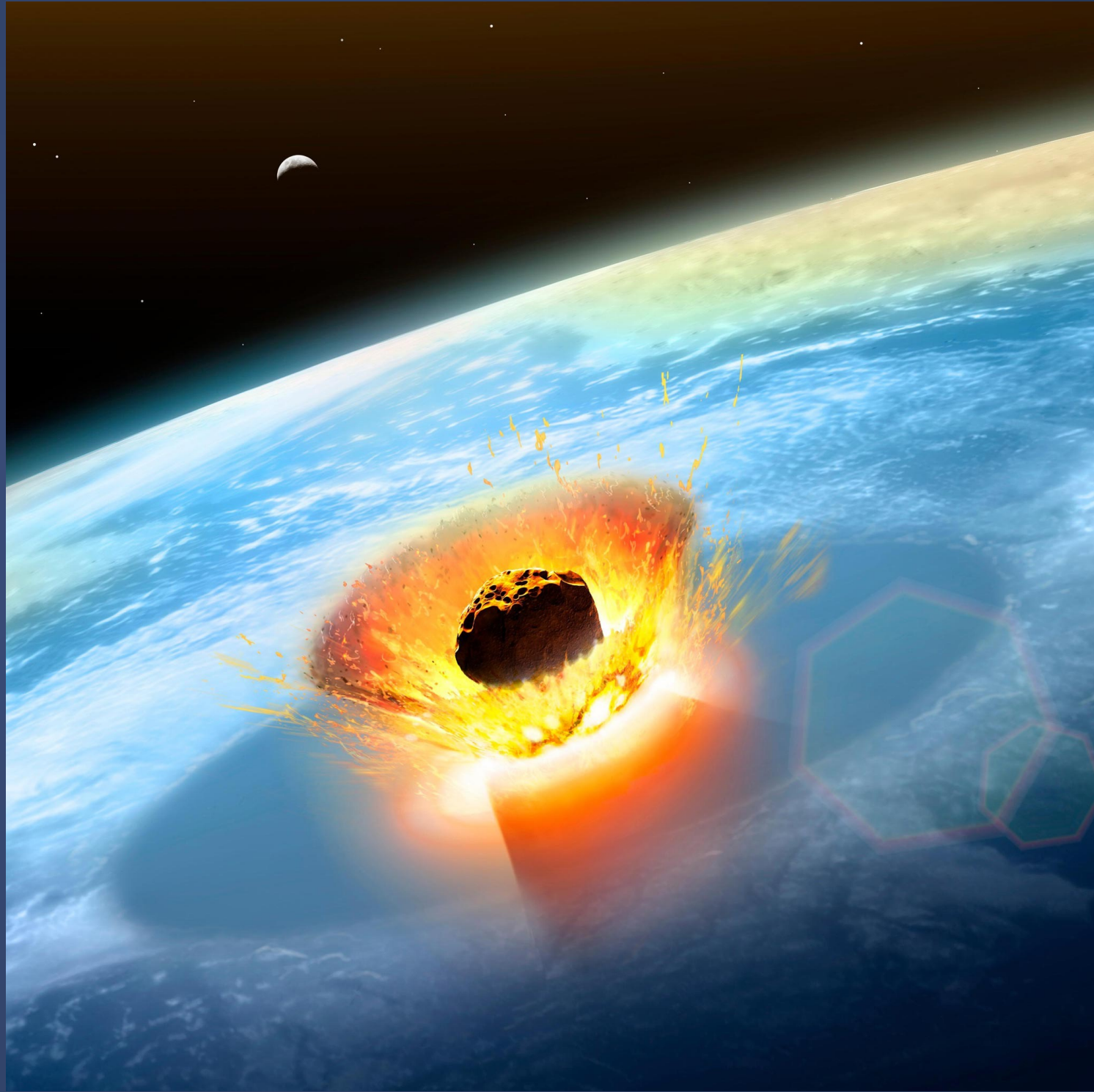


# LIFE ONLY POSSIBLE IN A NARROW CRITICAL DIVIDE





# A CATASTROPHIC ASTEROID COLLISION 66 MAY SET THE STAGE FOR OUR COMING





## THE DAY THE DINOSAURS DIED

- The dust and soot blocked all sunlight for months. Photosynthesis stopped, killing plant life.
- More than 99.9999 per cent of all living organisms on Earth died.
- The dinosaurs that had ruled the Earth became extinct.



## THE AGE OF MAMMALS (OUR AGE) BEGAN

Insects feeding on dead leaves  
survived the collision



Small mammals survived  
eating insects





## THE EVOLUTION OF THE UNIVERSE HAS BEEN GOOD TO US

- Just an infinitesimal change and stars would not have formed.
- Or the stars would have burned out too quickly.
- Even an accidental asteroid collision prepared for us.
- As one physicist puts it: It seems that the universe knew we were coming.



## IS IT "CHANCE": MULTIVERSE THEORY

### Multiverse Explanation:

Where are an almost infinite number of universes:  
A Multiverse.

- Statistically a hospitable universe would arise.
- But we can not travel to another universe.
- So we will never know.



## OR THE "PROVIDENCE OF GOD?"

For believers, we would say this comes from the  
**Providence of God.**

- The universe knew we were coming.
- Because Providence set the laws of the universe.
- Even the asteroid was Providence.